GENERAL DYNAMICS
Armament and Technical Products

39th Annual NDIA Conference

M423E1 2nd Safe Fuze Development

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NDIA Briefing (M423E1) Program Background

- December 2001, Army Fuze Board (AFSRB) recommended a MIL-STD-1316 based, dual safe fuze be developed to improve the safety of the M151 Warhead

- PM-ARM established M423 Fuze Modernization Program under the current production contract
  - ➤ Program initiated in June 2002 – GDATP systems contractor
    - Surveyed Industry for viable concepts
    - Conducted competitive procurement with participation of PM-ARM, Picatinny Fuze Division and NSWC-Indian Head
  - Subcontract award to Action Manufacturing for fuze development placed October 2002
  - Preliminary Concept Briefing to AFSRB 11 December 2002

NDIA Briefing (M423E1)
Problem Definition

- Mil-Std-1316 Requirement (5.3.3 b Explosive Train Interruption)
  - **5.3.3 Explosive Train Interruption. b.)** If the primary explosive is positioned such that omission of the interrupter prevents explosive train transfer, a single **interrupter locked by two independent safety features** is acceptable.
  - **4.2.1 Safety Redundancy.** The fuze shall contain at least **two independent safety features, each responding to a different environment.** At least one must sense an environment after first motion or sense post launch.

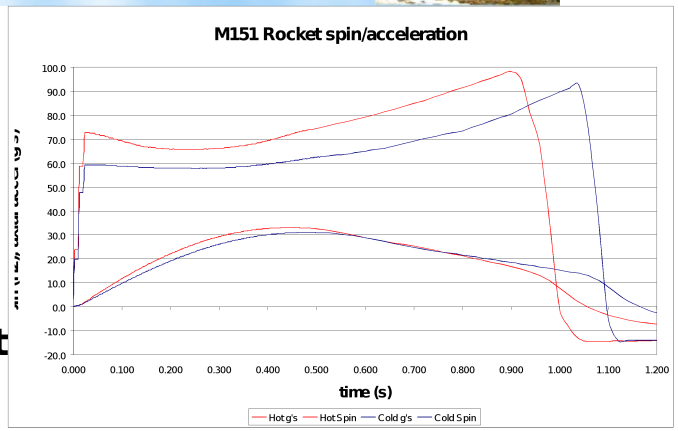
- Available Environments (2.75 inch Rocket):
  - Acceleration (Setback)
  - Spin Rate
  - Spin Acceleration
  - Deceleration (Set forward at Burnout)
  - Launcher Exit

Trade Study determined Acceleration (setback) and Spin Rate as the 2 different environments most suitable for M423E1

NDIA Briefing (M423E1)
2.75 inch Rocket System Description

Rocket Fire Signal/ Ignition

Rocket Motion (Acceleration & Spin)



Fuze Arms

Rocket Motor Burn Out

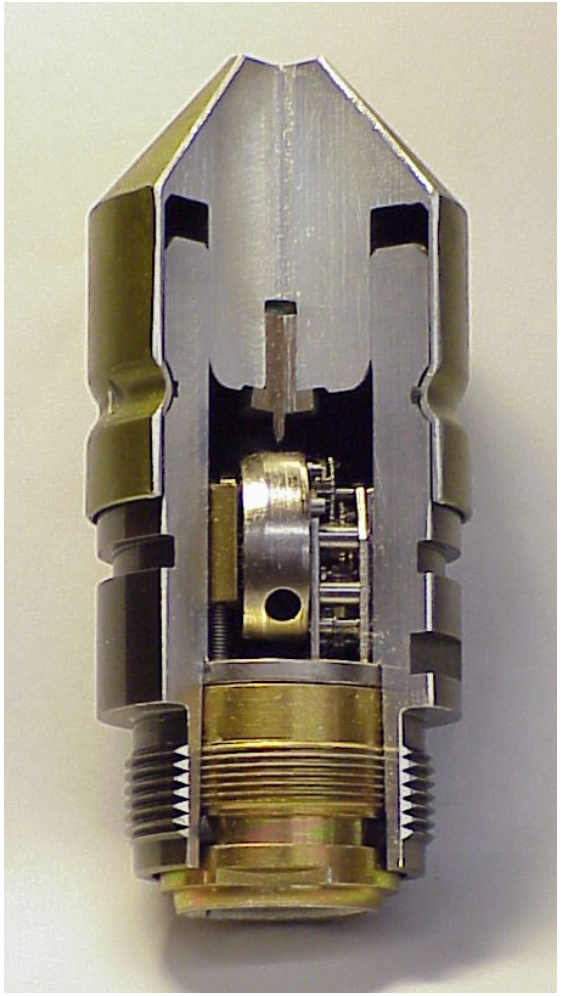
Fuze Strikes Target

Explosive Train Initiated

Warhead Functions High Order

NDIA Briefing (M423E1)
M423 Fuze Description

- The M423 fuze is a point detonating fuze for use on unitary warheads (M151, M229)
- Interrupter is an eccentric mass locked by a setback weight and meshed with runaway escapement mechanism
- Interrupter and setback weight sense axial acceleration
- Interrupter rotates to armed position, paced by escapement, providing separation distance
- Current reliability of fuze at LAT is 99.9%
- Does not comply with Mil-Std-1316

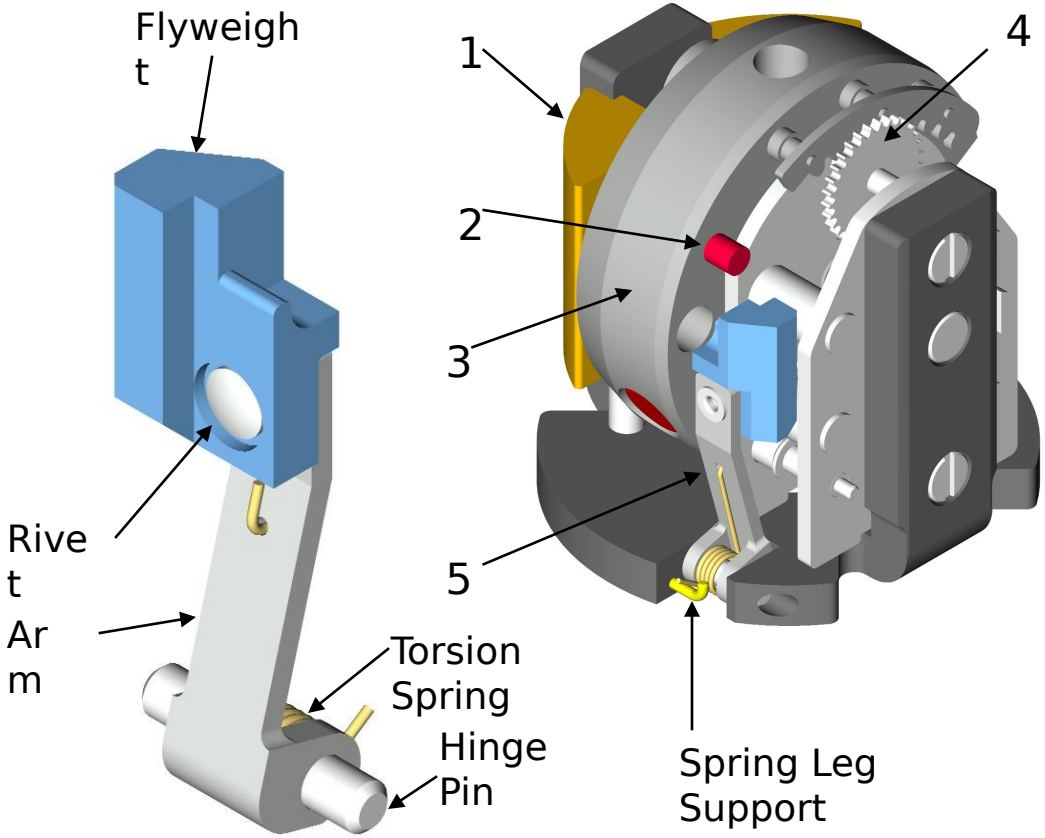


NDIA Briefing (M423E1)
M423E1 Requirements

- Design Requirements
  - ➤ Mil-Std-1316 Compliant
  - Maintain high reliability
  - Fits within M423 Fuze space claim
  - Compatible with existing 2.75 inch Rocket System
  - Simple, Low Cost solution
- Schedule Requirements
  - 3 Phase Approach
    - Phase 1 - Concept and Technical Development
    - Phase 2 - System Development and Demonstration
    - Phase 3 – System Safety Testing and Qualification
  - 27 month time frame ending with Type Classification

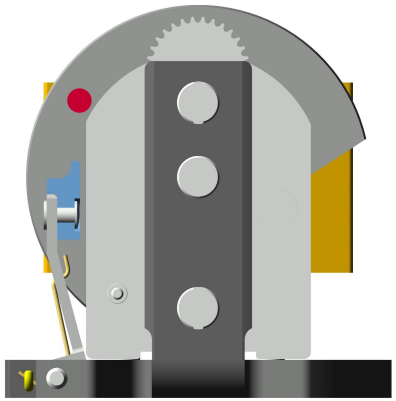
NDIA Briefing (M423E1)
2nd Safety Description

1) Setback Weight
2) Banking Stud
3) Interrupter (Rotor)
4) Escapement
5) Flyweight Assembly
   - Flyweight
   - Arm
   - Rivet
   - Torsion Spring
   - Hinge Pin
   - Spring Leg Support

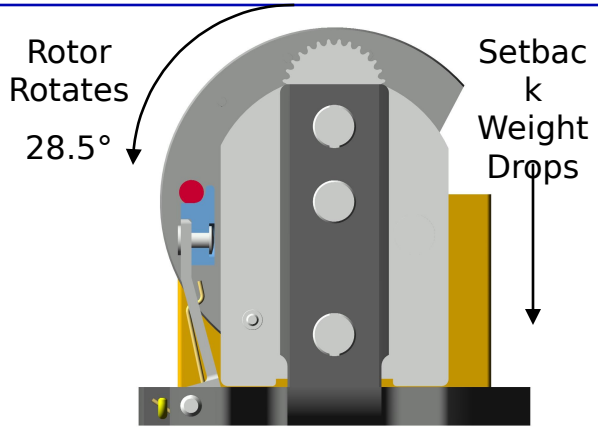


(Torsion spring, 9Hz - 1Hz preload)

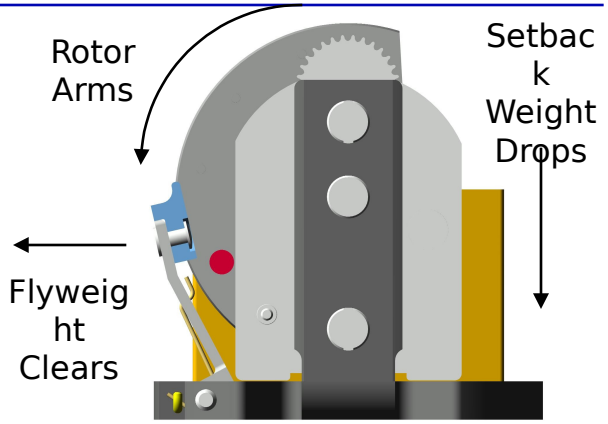
NDIA Briefing (M423E1)
S&A Operational Description



Safed Position
Prior to Launch



Rotor Blocked From Arming
Axial Acceleration, No Spin



Armed Position
Launch Acceleration and Spin

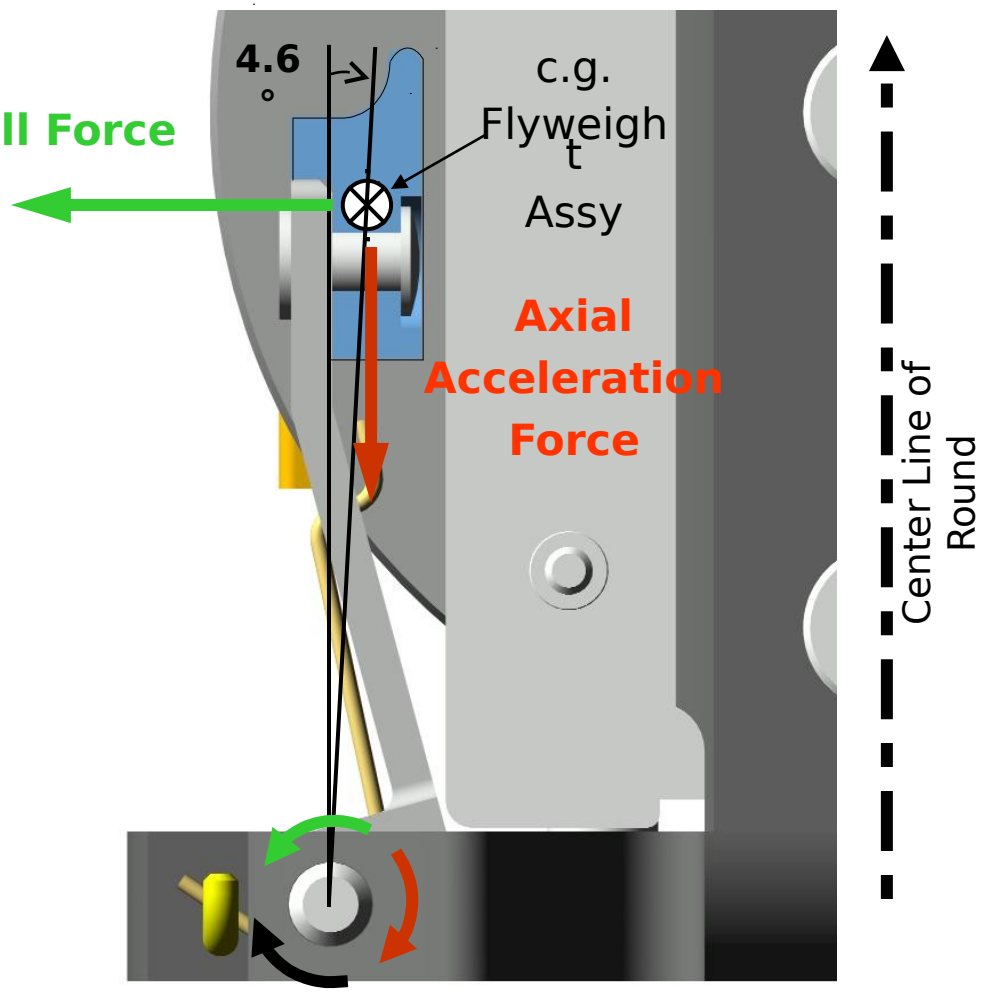
- Prior to Launch, the spring loaded Setback Weight locks Rotor in Safe Position.
- Upon Launch (axial acceleration), Setback Weight releases rotor.
- The eccentric rotor mass exerts force through the escapement gear train to an oscillating pallet lever.
- The pallet lever meters out setback load delaying the rotor as it rotates into the armed position.
- As rocket spin rate increases to ~12 RPS, centrifugal force drives the Flyweight outboard, clearing the path of the Rotor Banking Stud.
- When the Rotor rotates 60.8° it locks into the armed position
- Any fuze that fails to arm will return to the safed position.
- When the fuze strikes the target, the firing pin initiates the explosive train.

NDIA Briefing (M423E1)
2nd Safety Operation

- The torsion spring provides an initial torque from preload. Spring torque increases as the flyweight rotates out

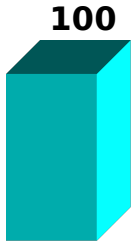
- As rocket axial acceleration increases, axial force increases, thus, torque at the hinge pin from acceleration increases

- As rocket spin rate increases, centrifugal force (roll force) increases, thus, torque at the hinge pin from roll increases



NDIA Briefing (M423E1) Ballistic Test Data

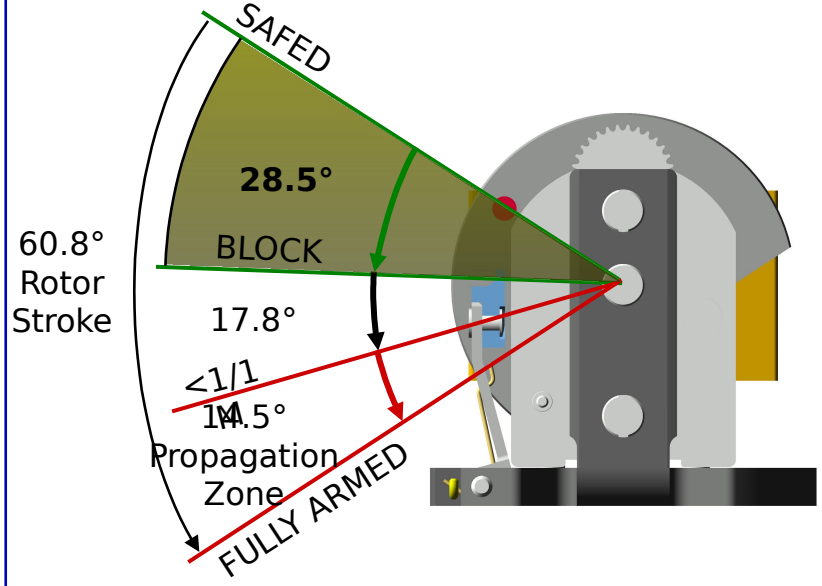
- Phase 1 Ballistic Testing at YPG last October
  - 8 Hot conditioned rounds (100% armed)
  - 29 rounds fired at 70F (76% armed)
  - 8 Cold conditioned rounds (50% armed)
  - Phase 1 Exit Criteria: 75% arm at 70F
  - Temperature dependent failure mode identified
  - Reliability Enhancements identified for Phase 2:
    - Relocate Banking Stud
    - Radial Flyweight Orientation
- Phase 2 Ballistic Testing at YPG
  - Dec, 03
    12 M423E1's w/ Banking Stud
    Relocated 14 deg. fired at -50F
    - 92% Armed
  - April, 04
    12 M423E1's w/ Banking Stud
    Relocation and Radial Flyweight
    Orientation fired at -50F
    - **100% Armed**



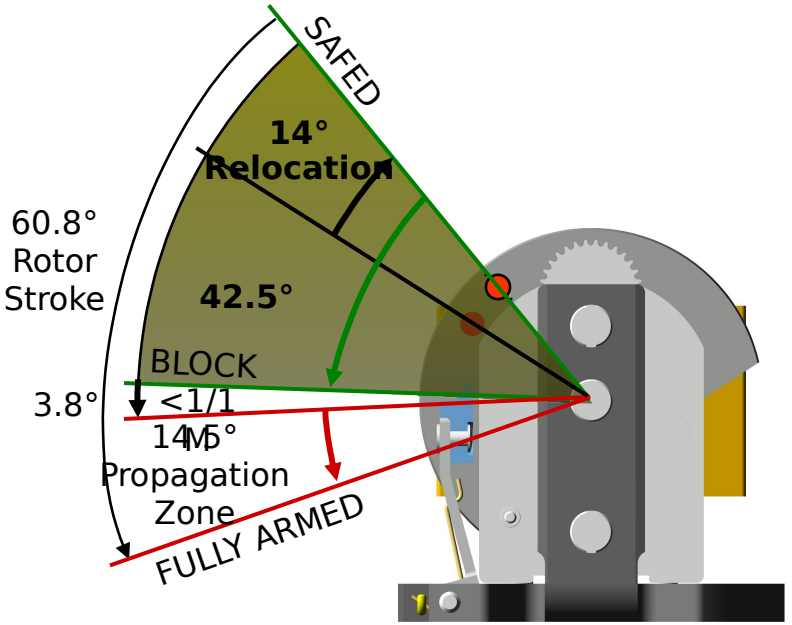
NDIA Briefing (M423E1)
2nd Safety Reliability Enhancement

Banking Stud Angular Relocation

- Previous configuration tested in Phase 1
  - Rotor rotates 28.5° to blocking position

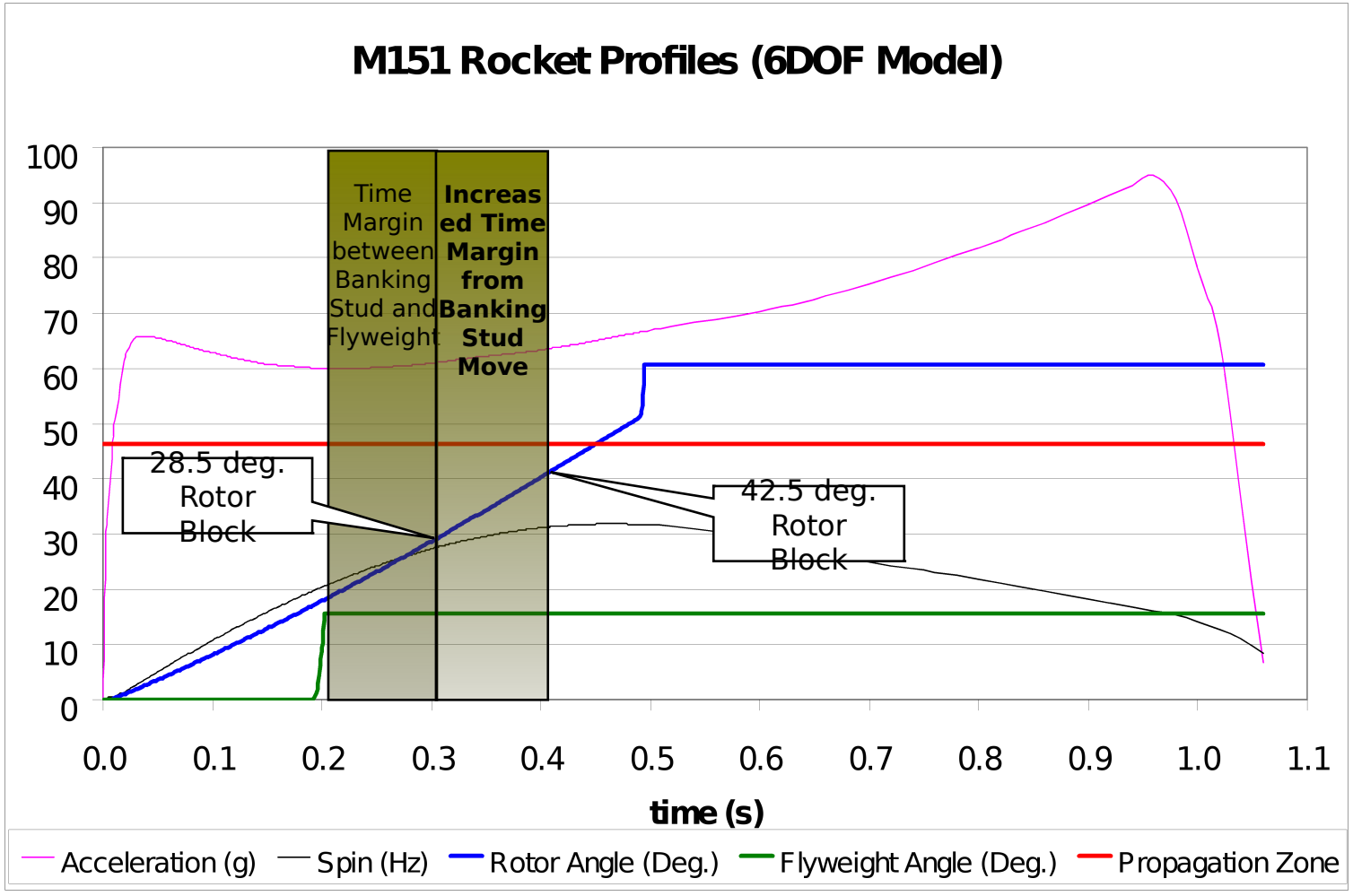


- New configuration tested in Phase 2
  - 14° angular relocation of Banking Stud
  - Rotor rotates 42.5° to blocking position



Improves reliability by increasing the time margin between Flyweight and Banking Stud

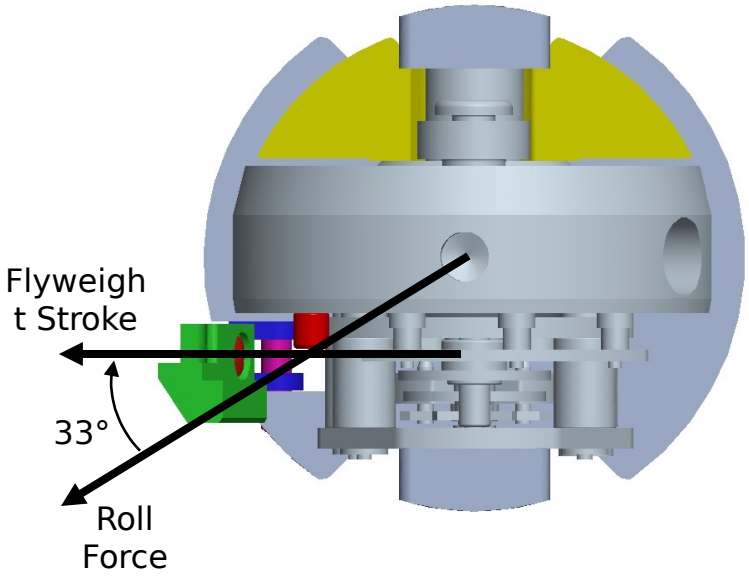
NDIA Briefing (M423E1)
Operational Sequence Diagram



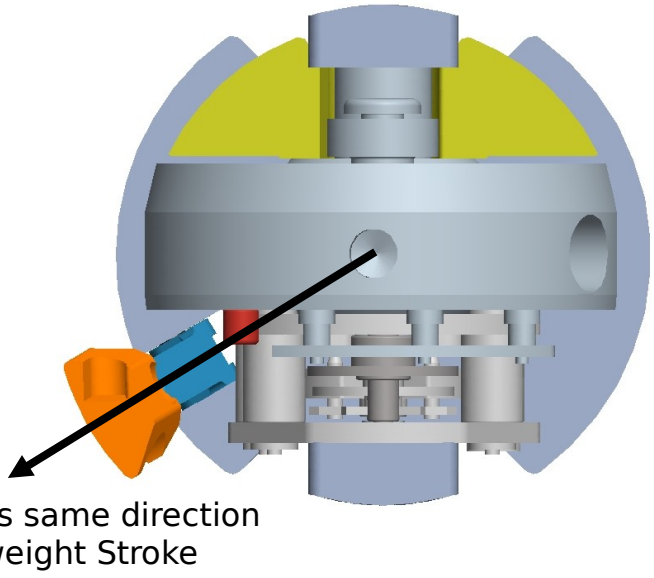
NDIA Briefing (M423E1)
2nd Safety Reliability Enhancement

Radial Flyweight Orientation

- Previous configuration tested in Phase 1
  - Flyweight stroke is at 33° angle to spin center
  - Roll Force = Mass * Normal Accel * Cos(33°)
  - Cos 33° = 0.83 (17% of Roll Force Lost)



- Radial configuration tested in Phase 2
  - Flyweight stroke intersects spin center
  - Flyweight senses 100% of Roll Force



Roll Force is same direction as Flyweight Stroke

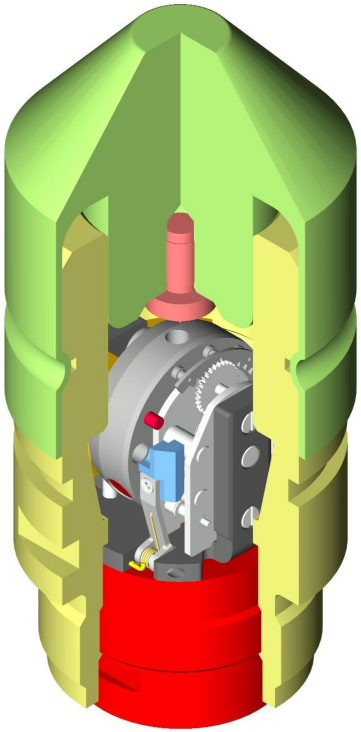
Improves reliability by allowing Flyweight to sense 100% of available roll force

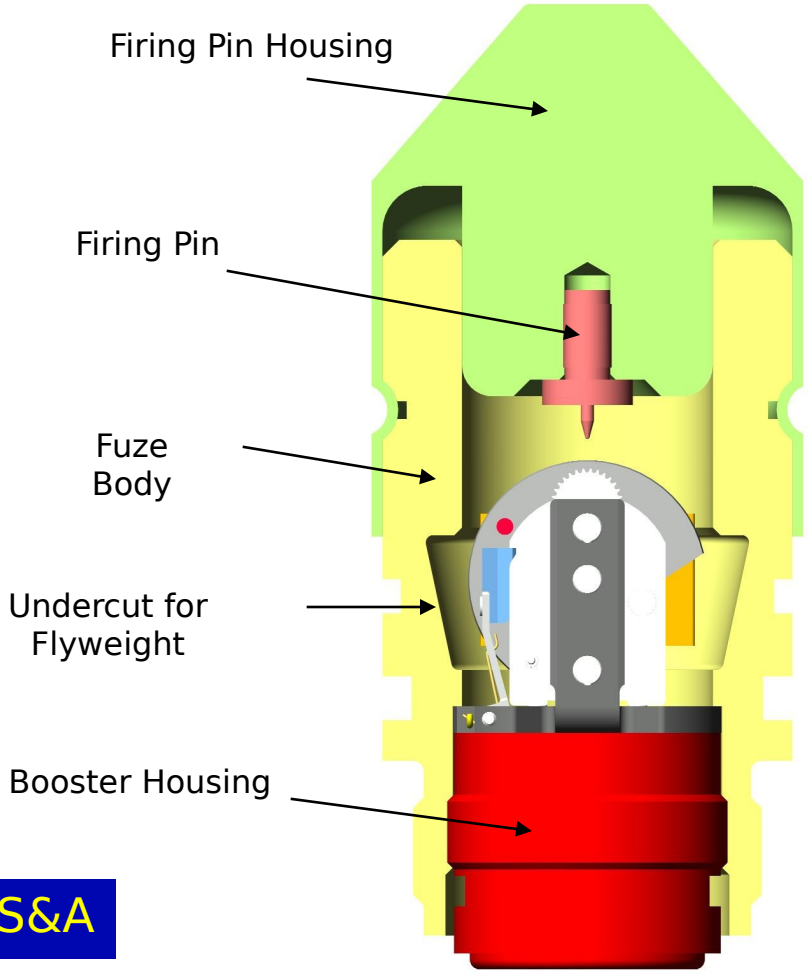
NDIA Briefing (M423E1) Summary

- Performance
  - Mil-Std-1316 deficiency has been addressed
    - 2nd Safety Mechanism utilizes rocket spin environment
  - Ballistic test performance is on track to meet reliability requirement
  - Fits in M423 envelope and is compatible with existing 2.75 inch Rocket System as well as the Guided System
  - Simple, low cost solution, compatible with existing inventory
- Schedule
  - Currently in Phase 2 (System Development and Demonstration)
    - Working on safety and reliability enhancements

Improves Safety of M151 Warhead-
S&A Mechanism Adaptable to 2.75 inch Warhead Family

BACKUP SLIDE





Prevents Assembly of Armed S&A